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OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Memorandum

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SUBJECT: Initial Cranberry Benefits Assessment for Azinphos-methyl and Phosmet Related to Proposed Occupational Risk Mitigation

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SUMMARY

Cranberries are a high-value perennial crop grown in five states on approximately 37,000 acres. Based on available published data and personal communications with crop experts, BEAD believes that the impacts resulting from extending the restricted entry intervals on cranberries for either phosmet or azinphos-methyl will be limited. Phosmet is a recent registration on cranberries (February 2000) and BEAD has not located any grower that is currently using this chemical. In most regions of the country, the use of azinphos-methyl on cranberries appears to be declining, but is still used as a key pest management component. Adequate alternatives appear to be both available and are currently efficacious (although pest resistance could develop in the future). BEAD believes that the most likely outcome resulting from extending the restricted entry interval is that growers will switch to alternative pest control methods, including increased usage of other organophosphate insecticides.

To provide an upper bound estimate of the impacts of the proposed post-application risk mitigation measures, BEAD estimated the impacts from a worst-case scenario for the grower-, state-, and national-level. Assuming the worst-case scenario (extending the REIs for azinphos-methyl causes abandonment of the chemical, with no replacement pest control method), the economic impact to the most severely affected individual growers could be as high as 10 percent of their gross revenues. At the state-level, the economic impact as a percent of gross revenue is about 2.5 percent. At the national-level, this worst case scenario could equate to a 0.2 percent loss of gross revenues.

In aggregate, state-level and national-level impacts could vary due to the mix of grower choices (e.g., continued use of azinphos-methyl, changing to alternative pest control methods, and abandonment of azinphos-methyl) and the resultant costs and yield impacts associated with each.

BACKGROUND

The American Cranberry (*Vaccinium macrocarpon*) is a low growing, creeping woody perennial shrub. The plant spreads vegetatively via horizontal stems (runners). Vertical shoots (uprights) from the leaf axils of the runners produce flowers that give rise to clusters of cranberry fruit. Cranberries are produced in Massachusetts, Wisconsin, New Jersey, Oregon, Washington, Rhode Island, Maine, and Connecticut.

The annual growth cycle of the cranberries in Massachusetts is typical of that for the crop, although the calender dates may vary due to geography and cranberry variety. Cranberry plants have a dormant season that usually lasts from November through April. After emerging from dormancy in May, vines develop new leaves. Flowering begins in mid June and the bloom lasts for three to six weeks. Berries reach maturity about 80 days after flowering and are harvested from early September through early November (USDA, 2001).

Cranberry beds range in size from less than an acre to over 200 acres. Originally, cranberry beds were built in natural wetlands by draining peat bogs. Once drained, the bogs were cleared of vegetation, leveled, and covered with sand and then planted with cranberry vines. Because of environmental regulations protecting wetlands, all new beds are built in more “upland” sites that are engineered to match hydrological and soil characteristics of the traditional bogs. Once established and properly maintained, beds may remain productive for more than 50 years.

Several cultural practices are important in maintaining the productivity of established cranberry beds. Beds are pruned by machine after harvest to stimulate the production of the uprights and to reduce the matting of the runners. Sanding involves the application of a ½ to 2 inch layer of sand to the bed every 3 to 4 years. This layer increases the rooting of the vines, improves drainage, reduces danger from frost injury, and aids in pest control by changing the organic material and the microhabitat of the overwintering insects. Water management is used not only to irrigate the crop, but is also used for pest control by this change in microhabitat.

Cranberries are harvested by two methods. Dry harvesting uses a picking machine that combs the fruit off the vines. This machine, about the size of a large self-propelled lawn mower, is operated by a worker walking behind the machine. Water harvesting involves flooding the beds just prior to harvest. A water-reel is used to knock the fruit off the vines. The buoyant berry rises to the surface and is moved with floating booms to the corner of the bed and is loaded into trucks with conveyer belts or pumps. Typically, dry harvested cranberries are sold into the fresh market and water harvested cranberries are sold to processors because the fruit is often damaged during harvest and may be more susceptible to bruising and pathogens. The great majority of cranberries are water harvested.

Cranberries are grown commercially primarily in five U.S. States. In the Northeast, the major cranberry states are Massachusetts and New Jersey (with minor acreage in Rhode Island, Maine, and Connecticut). Massachusetts and New Jersey produced 2,396,000 and 2,566,000 barrels on 18,300 and 18,800 acres in 1998 and 1999, respectively. In the Midwest, Wisconsin produced 2,252,000 and 3,340,000 barrels on 14,500 and 14,600 acres in 1998 and 1999, respectively. In the Pacific Northwest, Oregon and Washington produced 523,000 and 467,000 barrels on 3,800 and 3,900 acres in 1998 and 1999, respectively (NASS, 2000).

The National Agricultural Statistics Service forecasts the 2000 cranberry crop to be 5.84 million barrels (1 barrel = 100 pounds or 1 cwt), down 8 percent from 1999 but 7 percent above 1998. The value of the cranberry crop was 211 million dollars in 1998 and 108 million dollars in 1999 (NASS, 2000). This amounts to a 48 percent reduction in value in one year. Personal communication with crop experts indicate that this rapid drop in price resulted from increased production and inelastic demand for cranberry products.

USE OF AZINPHOS-METHYL AND PHOSMET ON CRANBERRIES

Azinphos-methyl: – An average of 39 percent of the total cranberry acres were treated with azinphos-methyl in 1996 and 36.5 percent of the total cranberry acres were treated in 1998 (USDA, 2001; Downing and Deziel, 1999). Recent use of azinphos-methyl has declined in all states except Wisconsin (Table 1).

Table 1. Percent Cranberry Acreage Treated with Azinphos-methyl (USDA, 2001; Downing and Deziel, 1999).

State	1996		1998	
	Acreage	Percent Crop Treated	Acreage	Percent Crop Treated
New Jersey	3,917	43	3,795	17
Massachusetts	14,194	26	13,370	18
Wisconsin	12,381	60	14,211	66
Oregon	2,079	5	2,121	3
Washington	1,513	30	1,617	15
United States (Total)	34,084	39	35,114	37

Use in the Northeast Region (Massachusetts and New Jersey): – The use of azinphos-methyl is declining in both Massachusetts and New Jersey.

Target Pests: – In New Jersey, azinphos-methyl is typically used to control cutworms – the cranberry tipworm [Dasineura oxycoccana (Johnson)], the false armyworm (Xylena nupera Lint.) and the cranberry blossomworm (Epiglaea apiata Gr.). Azinphos-methyl applications are generally made through bloom (mid May until July 20). Currently, applications of azinphos-methyl are alternated with chlorpyrifos to prevent the development of resistance. Use of azinphos-methyl to control these pests is considered a key component of the pest management program in New Jersey.

In Massachusetts, azinphos-methyl is used to control fireworms and cranberry fruitworm. It is rarely effective on the sparganothis fruitworm (Sparganothis sulfureana Clemens). In Massachusetts prior to the development of resistance, chlorpyrifos was used to control the sparganothis fruitworm and the cranberry weevil (Anthonomus musculus Say).

Alternative Pest Control Methods: Chlorpyrifos is the most effective alternative chemical control for cranberry tipworm, false armyworm, and cranberry blossom worm in cranberries. It is currently applied against these pests after pollination or bloom. Because Massachusetts has seen resistance to chlorpyrifos develop in these pests, New Jersey is currently rotating the application of azinphos-methyl and chlorpyrifos to reduce the potential for resistance problems. There are several other insecticides that are used on cranberries in New Jersey for these pests, including carbaryl, diazinon, acephate, and pyrethrins (USDA, 2000a). BEAD has no data on the relative effectiveness of these alternatives.

There have been an number of organophosphate-replacement insecticides either recently registered or are progressing toward registration. Recently registered insecticides include tebufenozide and Bacillus thuringiensis. Insecticides in review for registration include methoxyfenozide, spinosad, thiamethoxam, and imidacloprid (USDA, 2001). Additionally, advance testing of newer insecticides for use on cranberries is being done for emamectin benzoate and indoxacarb (USDA, 2001). These new insecticides will not provide the same spectrum of insect control as the organophosphates and may need to be applied in combination with other products to provide a similar range of pest control.

Several cultural control methods may be used to suppress or control populations of some of these pests in cranberries. Sanding, the spreading of a ½ to 2 inch layer of sand over the cranberry vines, reduces infestations of cranberry girdler, green spanworm, and cranberry tipworm. It also increases the effectiveness of insecticides in general by burying the organic trash layer so there is less insecticide binding to organic matter on the bed surface. Further, good sanitation in the bed and around its perimeter helps reduce pest populations by removing the weeds that serve as alternative hosts for insect pests.

The traditional method of pest control in cranberries is controlled flooding at various times throughout the growing season. Logistic problems (e.g., availability of adequate water supplies, type of bed) may prevent the use of controlled flooding in some areas. Existing populations of cranberry pests that can be controlled by flooding include sparganothis fruitworm, cranberry fruitworm, cutworms, false armyworm, green spanworm, fireworms, cranberry scale, and mites. Recent changes in the timing of winter flood removal have reportedly increased pest populations (USDA, 2000a). BEAD believes that this early removal of the winter flood is prompted by growers trying to increase their cranberry revenues by "shifting" the crop cycle by two to three weeks – resulting in an earlier harvest and a higher yield.

Biological control agents that are available for cranberry pests include a mating disruption pheromone for the control of the blackheaded fireworm and sparganothis fruitworm. Insecticidal nematodes are commercially available for some of the soil-inhabiting pests (USDA, 2001). Use of these biological control agents has not led to a significant reduction in pesticide usage.

Use in the Central Region (Wisconsin): - The use of azinphos-methyl has increased in Wisconsin. Based on personal communication with an entomologist in Wisconsin, azinphos-methyl is used primarily because of its lower cost. Using the national average price paid for insecticides (NASS, 2000b) and assuming the maximum label application rate on cranberries, the treatment cost for chlorpyrifos is $38.25 per acre, for phosmet $50 per acre, and for azinphos-methyl $18.40 per acre.

Target Pests: – The primary use of azinphos-methyl in Wisconsin is to control blackheaded fireworm, cranberry fruitworm (Acrobasis vaccinii Riley) and sparganothis fruitworm and minor pests such as cranberry tipworm.

Alternative Pest Control Methods: – A number of other chemicals are used in Wisconsin– carbaryl can be used to control fireworms and cranberry fruitworms; chlorpyrifos can be used to control fireworms, cranberry fruitworm, and sparganothis fruitworm; diazinon can be used to control fireworms, cranberry fruitworm, and cranberry tipworm; and tebufenozide can be used to control fireworms and sparganothis fruitworm. Biological and cultural controls are discussed above in the "Use in the Northeast Region" section and in the crop profile (USDA, 1998).

Use in the Western Region (Oregon and Washington): - Azinphos-methyl use in Oregon and Washington is declining. Personal communication with entomologists in these states indicate that other chemical control methods are currently used such as: acephate, carbaryl, chlorpyrifos, and diazinon. Biological and cultural controls are discussed above in the "Use in the Northeast Region" section and in the crop profiles (USDA, 1999a, 1999b).

Phosmet: – Phosmet was approved by the EPA for use on cranberries in February 2000. The Cranberry Institute requested that the manufacturer apply for a Section 3 registration to provide another insecticide option for its growers. Because of this recent registration, there are no data showing the amount of phosmet used on this crop. Phosmet is labeled for the control of various lepidopteran larval pests including blackheaded fireworm, gypsy moth and others (USDA, 2001). These are the same pests that azinphos-methyl and other chemicals are being used to control. If the use of other broad spectrum insecticides is restricted, phosmet may become much more important in the management of cranberry pests.

RESTRICTED ENTRY INTERVALS (REIs)

Azinphos-methyl: – The current restricted entry interval for azinphos-methyl use in cranberries is 4 days (increased to 5 days in regions where the average annual rainfall is less than 25 inches). The pre-harvest interval for this chemical is 21 days. Please refer to the Agency's occupational and residential risk assessments for azinphos-methyl posted at http://www.epa.gov/pesticides/op/ (see Schedule and Documents section) for information about occupational re-entry exposure risks. Lengthening the restricted-entry interval beyond approximately 7 days would critically impact agronomic practices such as hand weeding, sanding, and ditch maintenance.

Phosmet: – The current restricted entry interval for phosmet in cranberries is 24 hours. Phosmet has a 14 day pre-harvest interval for cranberries. Please refer to the Agency's occupational and residential risk assessments for phosmet posted at http://www.epa.gov/pesticides/op/ (see Schedule and Documents section) for information about occupational re-entry exposure risks. Lengthening the restricted-entry interval beyond approximately 7 days would critically impact agronomic practices such as hand weeding, sanding, and ditch maintenance. .

IMPACTS RELATED TO OCCUPATIONAL RISK MITIGATION

Phosmet: – Because this chemical is a new registration on cranberries (February 2000), there is no historical information concerning its use on this crop. Further, USDA Crop Profiles on cranberries do not report or recommend the use of this chemical. Based on this lack of information to the contrary and the availability of numerous alternatives, BEAD concludes that extending the restricted entry intervals for phosmet would have no significant present impact on the production of this crop.

Azinphos-methyl: – This chemical, although its use on cranberries appears to be declining, remains a key pest management component for this crop. If the restricted entry intervals were extended longer than the current five days, critical irrigation and hand weeding worker activities could effectively be prohibited. Growers would then have to choose between the following options:

- Option 1. Continue use of azinphos-methyl and abandon potentially critical hand weeding and irrigation activities until the restricted entry interval expires.
- Option 2. Change to alternative pest control methods (some of which may not be as cheap or effective as azinphos-methyl).
- Option 3. Abandon use of azinphos-methyl (without replacement with other pest control methods) and suffer some loss from the insect pests. This option would reflect the development of pest resistance to alternatives.

BEAD believes that some growers will choose the first option and will continue to use azinphos-methyl with the extended restricted entry intervals and postpone hand weeding and irrigation activities. These growers would likely have cranberry beds exhibiting low weed pressure and have irrigation systems in place that can be operated with "no-contact" with the treated crop. BEAD has no information as to the number of growers that would make this choice.

BEAD and some state specialists believe that most growers would choose the second option. In the near-term, BEAD would not expect to see any grower, regional, or national level impacts from extending the restricted entry intervals for azinphos-methyl on cranberries. There appear to be a number of effective chemical, biological, and cultural pest control alternatives for the key insect pests in this crop. However, it is of concern that heavy use of the most cost-effective and efficacious alternative (chlorpyrifos) will likely result in key insect pests becoming resistant to this chemical. In the longer-term, BEAD would expect to see the newer, effective insecticides become widely available to the cranberry industry. It is likely that these newer pesticides will be more expensive than azinphos-methyl and that growers will need to apply combinations of these insecticides to provide the same broad pest spectrum further increasing the cost to the grower.

BEAD believes that only a few growers may choose the third option. Ideally, the worst case scenario would be based on the state with the highest azinphos-methyl use. Unfortunately, data for infestations and yield losses from Wisconsin are lacking. However, using New Jersey data, where azinphos-methyl is a key component of their pest management strategy for control of cranberry tipworm, false armyworm, and cranberry blossomworm (i.e., cutworms), BEAD estimates the economic impact of this choice (Option 3) below at the grower-level, state-level, and national-level as a reasonable worst case scenario.

General Input Values and Assumptions

- BEAD assumes that in New Jersey, 25 percent of the cranberry crop is infested with cutworms and that all (100 percent) of these infested acres are treated with azinphos-methyl. This value is an estimate based on a personal communication with crop experts. BEAD considers this value to be a high-end at the state-level because of the declining use of azinphos-methyl (Table 1) and that azinphos-methyl is used for pests other than cutworms. In 1998, 17.4 percent of the cranberry crop was treated with azinphos-methyl (USDA, 2001).

- A moderate, uncontrolled infestation of cutworms will produce a ten percent yield loss in the affected cranberry beds. Based on personal communication with crop experts, BEAD considers this to be a central value.

- BEAD assumes that there will be no stand loss resulting from the moderate, uncontrolled infestation of cutworms. This assumption is based on personal communication with a crop expert.

- The nationwide market price of cranberries is assumed to be $25 per barrel. BEAD considers this to be a central value as the national average market price per barrel was $38.80 and $17.00 in 1998 and 1999, respectively (NASS, 2000).

- The New Jersey market price of cranberries is assumed to be $20 per barrel. BEAD considers this to be a central value as the average New Jersey market price per barrel was $26.30 and $10.70 in 1998 and 1999, respectively (NASS, 2000).

- Average yield per acre of a New Jersey cranberry bed is 150 barrels (1 barrel = 100 pounds or 1 cwt). BEAD considers this to be a central value as yield per acre in New Jersey was 133.6 and 172.8 barrels per acre in 1998 and 1999, respectively (NASS, 2000). BEAD also uses 150 barrels per acre as a nationwide average. BEAD considers the nationwide value of 150 barrels to be a low to central value as the nationwide average yield per acre was 148.7 and 170.9 barrels per acre in 1998 and 1999, respectively (NASS, 2000).

- New Jersey harvests 3,900 acres of cranberries per year. BEAD considers this to be a central value as cranberry acreage harvested was 3,900 and 4,000 in 1998 and 1999, respectively (NASS, 2000).

- BEAD is only including one year of crop loss in this analysis.

- BEAD assumes that losses in yield are directly proportional to the extent of the uncontrolled infestations of cutworms. For example, a moderate, uncontrolled infestation of cutworms that produces a ten percent stand loss of the affected cranberry plants will result in a ten percent reduction in yield.

Individual Grower-level Economic Impact

- As of July 2000, New Jersey had 47 farms growing approximately 3,900 acres of cranberries (USDA, 2000a). To estimate the worst case individual grower-level impact, BEAD has selected a hypothetical farm growing 80 acres of cranberries, all of which were harvested. BEAD assumes that all acres on this farm are moderately infested with uncontrolled cutworms. This worst case scenario would represent a situation in which cutworms have developed resistance to all alternatives.

- Gross revenues are equal to the product of acres grown, yield, and price. For the typical New Jersey cranberry farm without cutworm loss, gross revenue is $240,000 (80 Acres * 150 Barrels per Acre * $20 per Barrel).

- Yield losses are equal to the product of acres grown, percent infestation, percent loss per infested acre, yield, and price. For the typical New Jersey cranberry farm with moderate, uncontrolled cutworm infestations, the yield loss is $24,000 (80 Acres * 100 Percent of Acres Infested * 10 Percent Loss per Infested Acre * 150 Barrels per Acre * $20 per Barrel). Total grower costs are equal to that from yield losses.

- Total grower costs as a percent of gross revenue is equal to the total grower costs divided by the gross revenue. For the typical New Jersey cranberry farm with moderate, uncontrolled cutworm infestations, the total cost as a percent of gross revenue is 10 percent ($24,000 / $240,000).

State-level Economic Impact

- For this assessment, BEAD assumes that all New Jersey cranberry growers experience the average pest pressure (25 percent infestation).

- Gross revenues are equal to the product of acres harvested, yield, and price. For New Jersey cranberry growers without cutworm losses, gross revenues are $11,700,000 (3,900 Acres * 150 Barrels per Acre * $20 per Barrel).

- Yield losses are equal to the product of acres grown, percent infestation, percent loss per infested acre, yield, and price. For New Jersey cranberry growers with moderate, uncontrolled cutworm infestations, the yield loss is $292,500 (3,900 Acres * 25 Percent of Acres Infested * 10 Percent Loss per Infested Acre * 150 Barrels per Acre * $20 per Barrel). Total state-level costs are equal to the yield losses.

- Total state-level costs as a percent of gross revenue are equal to the total state-level costs divided by the gross revenue. For New Jersey cranberry farms with moderate, uncontrolled cutworm infestations, the total state-level costs as a percent of gross revenue is 2.5 percent ($292,500 / $11,700,000).

National-level Economic Impact

- BEAD assumes that uncontrolled cutworm losses will be restricted to New Jersey. This assumption is supported by personal communication with multiple crop experts in every cranberry growing region and the review of all USDA Crops Profiles on cranberries.

- BEAD assumes that 37,000 acres of cranberries will be harvested in the United States. BEAD believes this is a central value based on 36,600 and 37,300 acres being grown in the US in 1998 and 1999, respectively (NASS, 2000).

- Gross revenues are equal to the product of acres harvested, yield, and price. For U.S. cranberry growers without cutworm losses, gross revenues are $138,750,000 (37,000 Acres * 150 Barrels per Acre * $25 per Barrel).

- Because losses are assumed to be restricted to New Jersey, the total national-level costs are equal to that for New Jersey alone (i.e., $292,500)

- Total national-level costs as a percent of national gross revenue is equal to the total national costs divided by the national gross revenue. For the U.S. cranberry industry, the total costs as a percent of gross revenue is 0.2 percent ($292,500 / $138,750,000).

Conclusion

Based on available published data and personal communication with crop experts, BEAD believes there will be limited impact from extending the restricted entry intervals on cranberries for either phosmet or azinphos-methyl. Phosmet is a recent registration on cranberries (February 2000) and BEAD has not located any grower that is currently using this chemical. In most regions of the country, the use of azinphos-methyl on cranberries appears to be declining, but is still used as a key pest management component. Adequate alternatives appear to be both available and are currently efficacious (although pest resistance could develop in the future). BEAD believes that the most likely outcome resulting from extending the restricted entry interval is that growers will switch to alternative pest control methods.

Assuming the worst-case scenario (extending the REIs for azinphos-methyl causes abandonment of the chemical, with no replacement pest control method; e.g., development of resistance), the economic impact to the most severely affected individual growers could be as high as 10 percent of their gross revenues. At the state level, the economic impact is about 2.5 percent of gross revenues. At the national level, this worst-case scenario could equate to 0.2 percent of gross revenues.

In aggregate, state-level and national-level impacts could vary due to the mix of grower choices (e.g., continued use of azinphos-methyl, changing to alternative pest control methods, and abandonment of azinphos-methyl).

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